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ADSORBTION STUDIES ON COPPER REMOVAL FROM INDUSTRIAL SLUDGE

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Abstract:

Industrialization and urbanization has resulted in excessive release of heavy metals into the environment has posed a great problem worldwide. The presence of heavy metal ions is a major concern due to their toxicity to many life forms. Hence, removal of copper from water and wastewater is important. Copper is a persistent, bio accumulative and toxic chemical that does not readily break down in the environment and is not easily metabolized. It may accumulate in human or ecological food chain through consumption or uptake and may be hazardous to human health or the environment. Some of the methods for removal of copper from industrial sludge are: Precipitation, Ion exchange, Solvent extraction process, Floatation and Adsorption. The low cost adsorbents such as sugarcane bagasse, rice husk, activated carbon, sawdust, coconut husk, oil palm shell, neem bark etc., are used in adsorption process for the removal of copper from wastewater. The main objective of this study is to optimize operating parameters such as pH, flow rate and bed depth for the effective removal of $Cu(OH)_2$ for both the adsorbent and to find maximum removal of copper with activated carbon and rise husk separately. In this study, copper sludge is procured from AT&S industry at nanjangud. The copper present in the sludge in the form of $Cu[OH]_2$ and where removed from aqueous solution using low adsorbents activated carbon and rise husk

1. Introduction:

General: Excessive release of heavy metals into the environment due to industrialization and urbanization has posed a great problem worldwide. Unlike organic pollutants, the majority of which are susceptible to biological degradation, heavy metal ions do not degrade into Harmless end products. The presence of heavy metal ions is a major concern due to their toxicity to many life forms [1]. There are several methods for removal of copper from industrial sludge like precipitation, ion exchange, solvent extraction process, floatation, adsorption etc. Among these processes adsorption is considered as the effective method since it is found quite useful due to its low maintenance cost, high efficiency and easy operation. A number of adsorbent materials have been studied for their ability to remove heavy metals and they have been sourced from natural materials and biological wastes of industrial processes. The low cost adsorbents such as sugarcane bagasse, rice husk, activated carbon, sawdust, coconut husk, oil palm shell, neem bark etc., are used in adsorption process for the removal of copper from wastewater [7]. In this study, copper sludge is procured from AT&S industry at nanjangud, Mysore district, Karnataka State The copper present in the sludge in the form of $Cu\ [OH]_2$ and where removed from aqueous solution using low adsorbents activated carbon and rise husk.

2. Objectives:

Aim of the present investigation is to carry out adsorption studies on an aqueous solution of copper produced from the sludge. An upflow fixed bed column with mixture of activated carbon and rice husk as adsorbents. The specific objectives of the present investigation are

- ✓ To optimize operating parameters such as pH, flow rate and bed depth for the effective removal of $Cu(OH)_2$ for both the adsorbent.
- ✓ To find maximum removal of copper with activated carbon and rise husk separately.
- ✓ To study the reactor performance for different bed depth.

3. Materials and Methodology:

Adsorbent Materials: The adsorbent materials used for the removal of copper are

- ✓ Rice husk and Activated Carbon

Preparation of Adsorbent:

Rice Husk:

- ✓ **Preparation of Rice Husk Biomass:** The raw material rice husk was obtained from rice mill. The rice husk was first washed thoroughly with distilled water to remove soil, mud and clay particles. It was then dried for 24 hours in sunlight. Later, the rice husk was milled and passed through 1.18mm sieve. The sieved material was collected. The sieved rice husk was then subjected to chemical treatment to enhance the strength of adsorption. Sodium hydroxide (NaOH) of 0.1N was used for chemical treatment. The sieved rice husk was soaked in 0.1N NaOH solution and left for 10min. It was then rinsed with distilled water and dried under sunlight.
- ✓ **Activated Carbon:** Powdered activated carbon was obtained from raghu chemicals Pvt.Ltd, Mysore. It was used as an adsorbent without any primary treatment. Table 3.1 shows the composition of the powdered activated carbon used as adsorbent.

Table 3.1: Composition of Powdered activated carbon

S.No	Constituents	Composition in %
1	Acid Soluble matter	3
2	Water soluble matter	1

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3	Iron	0.2
4	Chloride	0.2
5	Sulphate	0.2

Preparation of Standard Copper Solution: At first, a solution was prepared by dissolving about 0.39g cupric sulphate in 100ml distilled water. About 10ml of this prepared solution was taken and was make up to 100ml using distilled water. 1ml, 2ml and 3ml of this solution was taken and make up with distilled water for 100ml and thus 1, 2 and 3ppm of standard solution was prepared respectively. The prepared standard was then analysed for initial copper concentration.

Preparation of Slurry: The slurry was prepared by dissolving 250g of sludge in 5000ml of distilled water along with 250 ml of 10% Hcl(Lasheen, M.R., 2011) [25] and then stirred properly.

Estimation of Copper: The copper content in the sample was determined using Atomic Absorption Spectrometry (AAS) which is Vereian AA240 specification. In AAS, the sample was first vaporized and atomized in a flame, transforming it to unexcited ground state atoms, which absorb light at specific wavelength of 320 nm. A light beam from hallow cathode lamp whose cathode is made of the element in question is passed through the flame. Radiation is absorbed, transforming the ground state atoms to an excited state. The amount of radiation absorbed depends on the amount of the sample element present. Absorption at a selected wavelength is measured by the change in light intensity striking the detector and is directly related to the amount of the copper element in the sample.

Experimental Set Up: The experimental set up consists of an upflow fixed-bed column with a peristalatic pump and a slurry collector and is shown in Fig 3.1 and in Plate 3.3. Plate 3.1 shows the pebble arrangement within the column reactor and Plate 3.2 shows the column reactor filled with the adsorption media.

- ✓ **Up flow Fixed-Bed Column**: A glass tube of 50mm diameter and 1m length was used as column reactor. The reactor had four outlets for the collection of the sample. The first outlet was at a distance of 20cm from the bottom of the column. Whereas the other outlets were at a distance of 15cm from each other. The column was connected with a rubber pipe from the bottom of the column to the pipe of the peristalatic pump. The samples were collected from the outlet fitted at a height of 60cm.
- ✓ **Peristalatic Pump:** A submerged peristalatic pump was used to pump the slurry into the column reactor. The flow was maintained using a knob accordingly to have sufficient contact time with the adsorbent and the percentage removal of copper was observed at each interval and different flow rates.

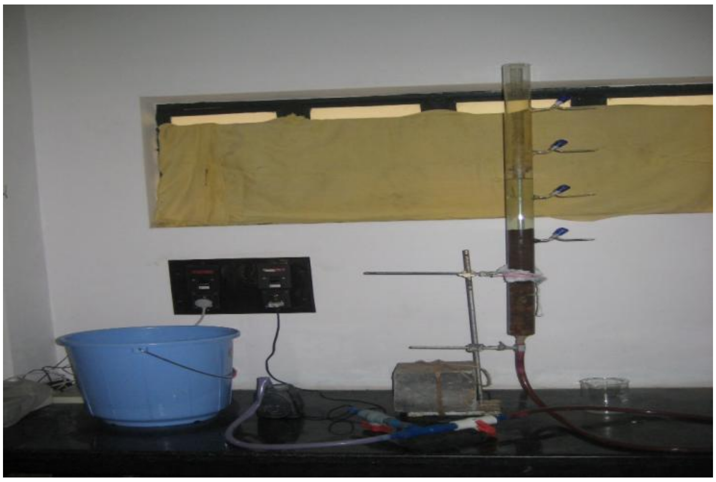

Plate 3.3: Photographic view of Experimental set up

The experimental procedure followed for the copper removal using an adsorbent has been described as follows

- ✓ Pebbles were filled up to a height of 20cm from the bottom in the column so as to support the adsorbent bed.
- ✓ A wire mesh was placed between the adsorbent bed and the pebbles so as to restrict the loss of adsorbent from the column.
- ✓ Adsorbent was filled above pebbles in the reactor column for a varying height of 15cm, 30cm and 45cm.
- ✓ The column was connected with submerged pump.
- ✓ The flow rate and pH was varied.
- ✓ The samples were collected at different pre-defined time interval.
- ✓ The collected sample was filtered with Whatmann filter paper no.44 and about 50 ml of the filtered sample was collected.
- ✓ The collected samples were analyzed for copper concentration by Atomic Absorption Spectrophotometer.

4. Results and Discussions:

Comparison of Copper Removal Efficiency between Rice Husk and Activated Carbon:

Comparison with Varying Flow Rate: Column studies were conducted for both rice husk and activated carbon. As per the discussion held in section 4.4.1 and 4.4.2 it was observed that the maximum copper removal for a bed depth of 15cm with the flow rate 2ml/min was 93% for activated carbon and 88.64% for rice husk. In the second set of analysis the bed depth was increased to 30 cm. Here, the maximum copper removal efficiency remained same for activated carbon i.e., 93.09% and it slightly

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reduced to 84.61% for rice husk for a flow rate of 2 ml/min. Finally, when the bed depth was increased to 45 cm the copper removal efficiency dropped significantly. Maximum copper removal was around 72% for rice husk and around 73% for activated carbon. Table 4.18 presents the comparison of copper removal efficiency between rice husk and activated carbon for varying flow rate.

Table 4.18: Comparison of copper removal efficiency between Rice husk and Activated carbon for varying flow rate

Bed depth in cm	Flow rate in ml/min	Maximum percentage removal for Rice husk	Maximum percentage removal for Activated carbon
15	2	88.64	93
	4	86.5	87.4
	6	85.3	80.98
30	2	84.61	93.09
	4	80.76	88.73
	6	67.46	84.19
45	2	72.63	73.45
	4	62	59.21
	6	55.75	51.97

Removal efficiency of copper was found to be highest in activated carbon in comparison with the rice husk in varied flow rate was varied. Fig 4.18, 4.19 and 4.20 shows the comparison of maximum percentage removal efficiency forRice husk and Activated carbon with changing bed depths.

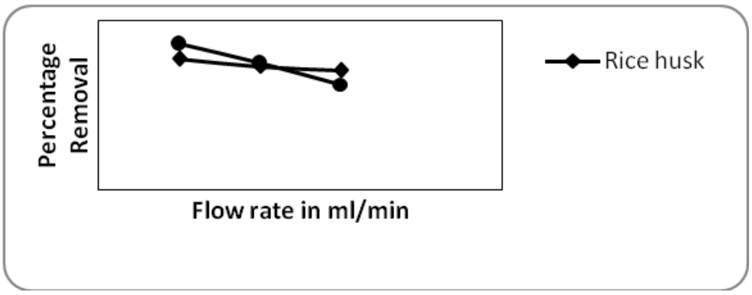

Figure 4.18: Comparison of maximum percentage removal efficiency forRice husk and Activated carbon for bed depth 15 cm

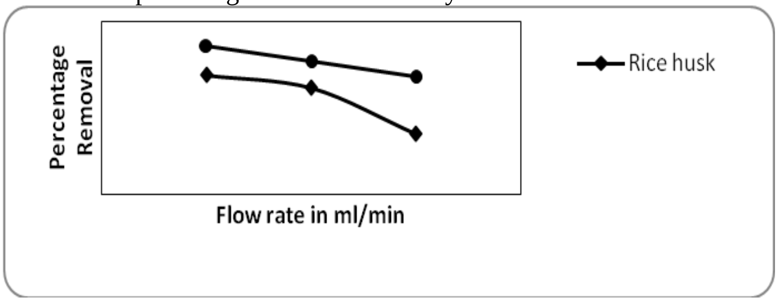

Figure 4.19: Comparison of maximum percentage removal efficiency forRice husk and Activated carbon for bed depth 30 cm

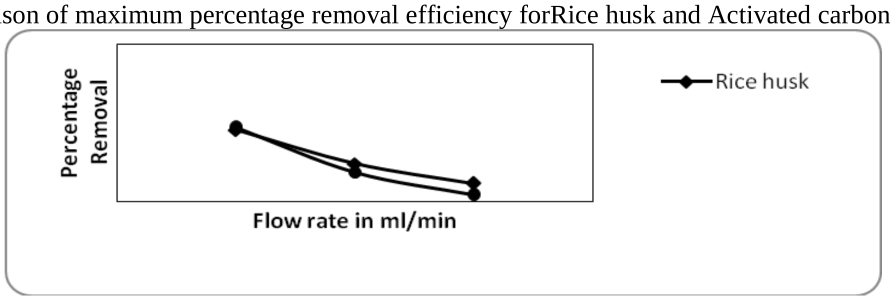

Figure 4.20: Comparison of maximum percentage removal efficiency forRice husk and Activated carbon for bed depth 45 cm

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